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ABSTRACT

The purposes of this study are to describe the development and validation of a research instrument for assessing teachers' beliefs regarding issues pertaining to the instruction of higher order thinking, and to explore the beliefs of Israeli science teachers regarding issues pertaining to instruction of higher order thinking. This paper describes differences between the beliefs of various groups of science teachers, and predicts several differences between various groups of Israeli science teachers. (Author)

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Assessing teachers' beliefs regarding issues pertaining to instruction of higher order thinking (# 200990)

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Objectives

This study has two objectives:

1. To describe the development and validation of a research instrument for assessing teachers' beliefs regarding issues pertaining to instruction of higher order thinking.
2. To explore the beliefs of Israeli science teachers regarding issues pertaining to instruction of higher order thinking.

Theoretical Underpinnings and Significance

Instruction that aims at challenging and developing students' thinking is currently at the center of reform curricula all over the world (e.g., Adey & Shayer, 1994; Brown, & Campione, 1990; Bruer,1993; Burden & Williams, 1998; Greeno & Goldman, 1998; Halpern, 1992; Lipman, 1985; Nickerson, Perkins & Smith, 1985; Paul, Binker, Martin, & Adamson, 1989; Perkins, 1992; Perkins & Grotzer, 1997; Resnick, 1987; Resnick & Klopfer, 1989; Schoenfeld, 1992; Sternberg, 1994; Swartz & Parks, 1994; Tishman, Perkins & Jay, 1995). Learning about teachers' knowledge and beliefs in this field has three important roles: First, numerous studies showed that teachers' knowledge and beliefs carry important significance for their practice, and thus influence students' learning (e.g., Brickhouse, 1990; Clark and Peterson, 1986; Nespor, 1987; Tobin and Fraser, 1989). Therefore, a study of teachers' knowledge and beliefs in the context of teaching higher order thinking would contribute to our understanding of learning processes that commonly take place in many of the "thinking" curricula mentioned earlier. Second, teachers' knowledge and beliefs have important implications for professional development because their initial knowledge is bound to affect what they would learn from a professional development course and how they would apply the course's content in their practice. Studying teachers'

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knowledge and beliefs in the context of teaching thinking is thus necessary for the design of successful and useful professional development courses in this field (Zohar, in press). Third, a study of teachers' beliefs regarding issues that pertain to instruction of higher order thinking may be used to design assessment for teachers' initial knowledge and for professional developments programs in this field.

Although many studies address teachers' knowledge and beliefs in specific science topics, we still know relatively little about teachers' knowledge in the area of teaching thinking. Our previous work employed qualitative methods to study teachers' knowledge and beliefs in the context of teaching higher order thinking (Zohar, in press). These studies identified several important components of teachers' knowledge in this field. We also developed a qualitative assessment instrument for teachers' pedagogical knowledge in the context of teaching thinking. The use of this instrument is limited, however, because it is costly in terms of being extremely time and labor consuming. Thus, in addition to the general significance of studying the field of teachers' thinking, the significance of the present work is in suggesting a paper and pencil, Likert - type research instrument. This instrument allows the exploration of a larger number of teachers than has been possible earlier by using our qualitative assessment, thereby enabling us to address a new set of questions and issues.

In this paper, we describe differences between the beliefs of various groups of science teachers. In the model of teachers' thought and action suggested by Clark and Peterson (1986), a double arrow is drawn between teachers' thought processes and their actions, representing a reciprocal relationship between these two domains. Thus, according to Clark and Peterson, teachers' actions are in large part caused by their thought processes, and thought processes are in turn influenced by teachers' actions. Indeed, empirical studies confirm that teachers' beliefs are indeed modified by their practice (e.g., Nagy and al., 1999). Based upon this assumption, we predicted several differences between various groups of Israeli science teachers. Due to space restrictions, only two of these differences are discussed here in detail.

First, during the past 30 years, high school biology instruction in Israel has been taught by applying a teaching by inquiry approach (Tamir and Jungwirth, 1975; Tamir, 1985; 1992), while physics and chemistry were taught by using more

traditional means. Thus, it may be hypothesized that biology teachers would score higher than physics and chemistry teachers on a questionnaire that assesses teachers' knowledge and beliefs regarding issues that pertain to instruction of higher order thinking. Second, because of the matriculation exams that require the coverage of large amounts of material, high school science teaching emphasizes rote learning of facts. Thus, it may be hypothesized that junior high school teachers, who are not yet forced to teach for the matriculation exams would score higher than high school teachers on that questionnaire.

Design and procedures

Instrumentation: The instrument we developed consists of 25 items. Five items refer to teachers' background information and twenty items ask teachers to mark the extent to which they agree/disagree with a set of statements (on a 1-5 scale). The questionnaire is based on findings from our previous qualitative studies (Zohar, in press) that identified several important categories pertaining to teachers' pedagogical knowledge in the context of higher order thinking. Seven of the items are based on previous work addressing elementary math teachers' knowledge (Griffin, 1997). These items were modified for use with junior-high and high-school science teachers. The questionnaire addresses the following categories:

- Teachers' attitudes regarding students' independent thinking and problem solving versus didactic and directive teaching. (e.g.: "The best way to begin teaching a new kind of problem is by demonstrating the correct way for solving this kind of problems", or: "Students will learn best how to solve problems if teachers will demonstrate detailed and specific methods for solving each type of problem").
- Teachers' beliefs regarding the role of cognitive conflict in learning (e.g.: In order to avoid frustrations during learning it is best to avoid situations in which new knowledge conflicts with students' pre-instructional knowledge").
- Teachers' beliefs regarding teaching higher order thinking to low-achieving students (e.g., "Teaching higher order thinking is an appropriate educational goal for high-achieving students, but it does not work so well with students who have low academic achievements".)

- Teachers' beliefs regarding means for treating students' 'wrong' answers (e.g.: "In order to avoid confusion it is best to avoid discussing students' wrong answers publicly in class", or: " When a student gives a wrong answer the teacher should correct it as soon as possible").
- Teachers' attitudes regarding the dilemma involved in "covering the curriculum" versus engaging students in deep thought-provoking activities (e.g.: In classes that prepare students for matriculation exams teachers should engage students in thinking activities only after all the curriculum for the test has been covered.").

Background information refers to school level (junior high school/ high school), subject (biology, physics, chemistry), stream of school (general/orthodox), academic degree and county.

The questionnaire was piloted with 60 science education graduate students. Items that were unclear to many students, or items that had low discrimination factor were taken out of the final version of the questionnaire. The final version was examined for content validity by two university professors who are experts in teaching higher order thinking.

Three additional questions were included in the questionnaires but not calculated in the final scoring. These "politically correct questions" use prevalent formulations about some of the main issues addressed by the questionnaire, in a way that reflects prevalent buzzwords concerning the teaching of higher order thinking. In the pilot testing most teachers answered these questions in a way that received the maximum score of 5, and thus they had a low discrimination factor. Nevertheless, these questions were not removed from the final version of the questionnaire in order to demonstrate the gap that exists between teachers' use of these buzzwords and their beliefs about specific ways of teaching.

Subjects: 150 science teachers participated in this study (90 high school teachers- 30 biology teachers, 30 physics teachers and 30 chemistry teachers; and 60 junior high school teachers who teach general science). These teachers were randomly sampled from lists of junior –high and high school science teachers in Israel.

Data Analysis: Data analysis took place using the following procedures (utilizing SPSS):

- Examination of the frequencies of teachers' responses to various items.
- Analysis of variance and calculation of effect sizes to compare scores of teachers with different background variables.
- Calculation of correlation between teaching experience and teachers' final score.

Findings

Reliability

A calculation of á Cronbach reliability test resulted in a value of 0.79.

Comparing junior high school to high school teachers

The findings show that junior high school teachers scored significantly higher than high school teachers with effect size of 0.36 (see table 1).

Table 1: Differences between junior high school and high school teachers

	N	Mean Score	SD	Effect Size	t test
Junior high school	60	65.23	12.3	0.36	-2.2*
High School	90	60.82	11.83		

Comparing biology, physics and chemistry high school teachers

The comparison among the scores of biology, chemistry and physics high school teachers revealed substantial differences. Biology teachers gained a significantly higher score than either physics or chemistry teachers, with high effect sizes (0.83 and 0.75 respectively, see table 2).

Table 2: Differences between biology, physics and chemistry high school teachers

Subject	N	Mean Score	S.D	Effect sizes

Biology	30	67.33	7.69	Biology: physics	0.83
Physics	30	56.79	12.67	Biology: chemistry	0.75
Chemistry	30	58.33	11.94	Chemistry: physics	0.12

Comparing teachers' from various academic backgrounds and school streams

No significant differences were found between teachers of various academic backgrounds (teachers with a Bachelor degree versus teachers with a Masters degree or a Ph.D.). Teachers who work in the general school stream scored significantly higher than teachers who work in the religious stream ($\bar{X}$ =63.53 and $\bar{X}$ =59.34 respectively, t=1.78, P<0.05) with an effect size of 0.34.

Correlation between final scores and teaching experience

A significant negative correlation was found between final scores and teaching experience: The longer teachers have been teaching the lower they scored on the questionnaire (r=-0.317; P<0.000)

Gaps between "politically correct" items and teachers' beliefs about specific ways of teaching.

Large gaps were found between teachers' responses in the "politically correct" items and their responses regarding beliefs about specific ways of teaching. Although space restrictions do not allow the examinations of specific examples, it is important to note that this finding shows that teachers beliefs regarding teaching higher order thinking are inconsistent and involve contradictions. On the one hand, teachers declare that they support teaching that applies thinking and inquiry. On the other hand, when asked about specific desirable means of instruction, teachers support practices that match a transmission of knowledge way of instruction.

Summary

The findings show that the instrument we developed for assessing teachers' beliefs regarding issues that pertain to instruction of higher order thinking is valid and reliable. A reasonable reliability was established by the α Cronbach test. The two experts who reviewed the questionnaire supported content validity. Construct validity was supported by findings from the study of 150 Israeli science teachers, because the instrument was found to be sensitive to differences between various groups of

teachers and because these differences were in accordance with our predictions. Biology teachers indeed scored significantly higher than chemistry and physics teachers, and junior high school teachers indeed scored higher than high school teachers.

The inconsistencies found between teachers' "politically correct" statements about teaching thinking and their beliefs about specific means of teaching may hinder successful implementation of a "thinking" curriculum. In order to promote successful teaching of higher order thinking teachers' educators must address these contradictions in professional development programs.

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